Space Weather Technical Forecast

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Issued on Thursday, 12 September 2024 at 00:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2 storm expected, possibly G3, on Friday 13 September. Slight chance of S1 minor radiation storm throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was Moderate, with a peak flare of M2.0 at 11/1752 UTC from AR3814, just west of the central meridian, in the north.

There are currently nine sunspot regions on the visible disc. Most of the active regions are now on the western hemisphere and appear to be relatively simple and stable. The largest and most complex region is AR3814, just west of the central meridian, in the north. This region recently developed a new delta configuration on its intermediate portion, exacerbating its magnetic instability, as can be seen on satellite imagery. The region immediately east of this, AR3822, appears weaker, with the loss of a couple of spots on its trailing portion. The most significant growth was seen in the newly numbered AR3824 in the southeast quadrant. This has shown rapid development in the recent hours, and it appears to have a delta spot forming within its asymmetric leader spot. This region is now classified a Dai/Beta-Gamma-Delta. AR3821 in the northwest has faded to plage.

No Earth-directed CMEs have been observed during the period. There is a significant amount of filaments present on the western hemisphere; any lift-off would probably be Earth-directed given their location on the sun.

Solar Wind / Geomagnetic Activity: The solar wind measured by ACE at L1 indicated a mostly slow regime. The solar wind fluctuated between 330-400 km/s, despite the late arrival of the 08 Sep CME at 11/1425UTC. Density was below average initially, but increased to above average with the arrival of the CME, with a peak of 26 ppcc observed at 11/1530UTC, gradually reducing back to mostly below average. The phi angle was largely negative (towards the Sun) initially, but switched to become mostly positive (away from the Sun) since 11/0900 UTC. The Interplanetary Magnetic Field (IMF), Bt, was initially weak, but increased to moderate with the arrival of the CME, peaking at 12nT at 11/1730 UTC. The north-south component, Bz, was weak, but became weakly negative (southward) ranging between +6 to -6 nT.

The net result of the above solar wind measures was the result of a weak CME arriving at Earth, with geomagnetic activity initially Quiet (Kp1-2), but increased to Unsettled (Kp3) between 11/0900 to 1500UTC, with an Active interval at 11/1500-1800UTC, before returning to mostly Quiet conditions.

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Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 continually decreased during this period, eventually returning to background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels, with a peak of 332 pfu at 11/2000UTC. The associated 24-hour fluence remained below the Active threshold, with 2.53e6 integrated pfu observed at 12/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely to continue throughout, with a daily Slight Chance of X-class flares. The complexity and flare risk of oncoming sunspot regions is likely to exceed that from any departures through midweek UTC, and the overall risk is upwards around this time.

Solar Wind / Geomagnetic Activity: The weak CME (from the 08 Sep) which arrived late on 11 Sep should will soon pass. There is only one Earth-directed CME in the forecast, which was observed leaving the Sun early on the 10 Sept, following an M1.2 flare. This is expected to give a direct hit, arriving either late on Day 1 (12 Sep) or early on Day 2 (13 Sep). Any CME influence may also persist into Day 3 (14 Sep), gradually waning. Enlil is currently offering a reasonable representation of the current solar wind conditions, and it is felt correct in delaying any fast wind arrival from CH68/- until Day 4 (15 Sep).

On balance, Quiet to Unsettled conditions should persist for much of Day 1 (12 Sep), followed by an increasing risk of G1-G2/Minor-Moderate Storms early on Day 2 (13 Sep) with a slight chance of G3 / Strong Storm interval. The CME impacts probably lingering into Day 3 (14 Sep), with further Unsettled or perhaps Active intervals. A combination of waning CME influences and the arrival of a high speed stream from CH68/- may increase geomagnetic activity back up to G1 storm levels on Day 4 (15 Sep), although this is low confidence.

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings a daily chance of reaching/exceeding the S1 Minor Radiation storm level, should any significant flares occur from active regions in the western hemisphere. High energy electron flux is expected to remain near current Normal Background levels throughout, with Active 24-hour fluence not expected.

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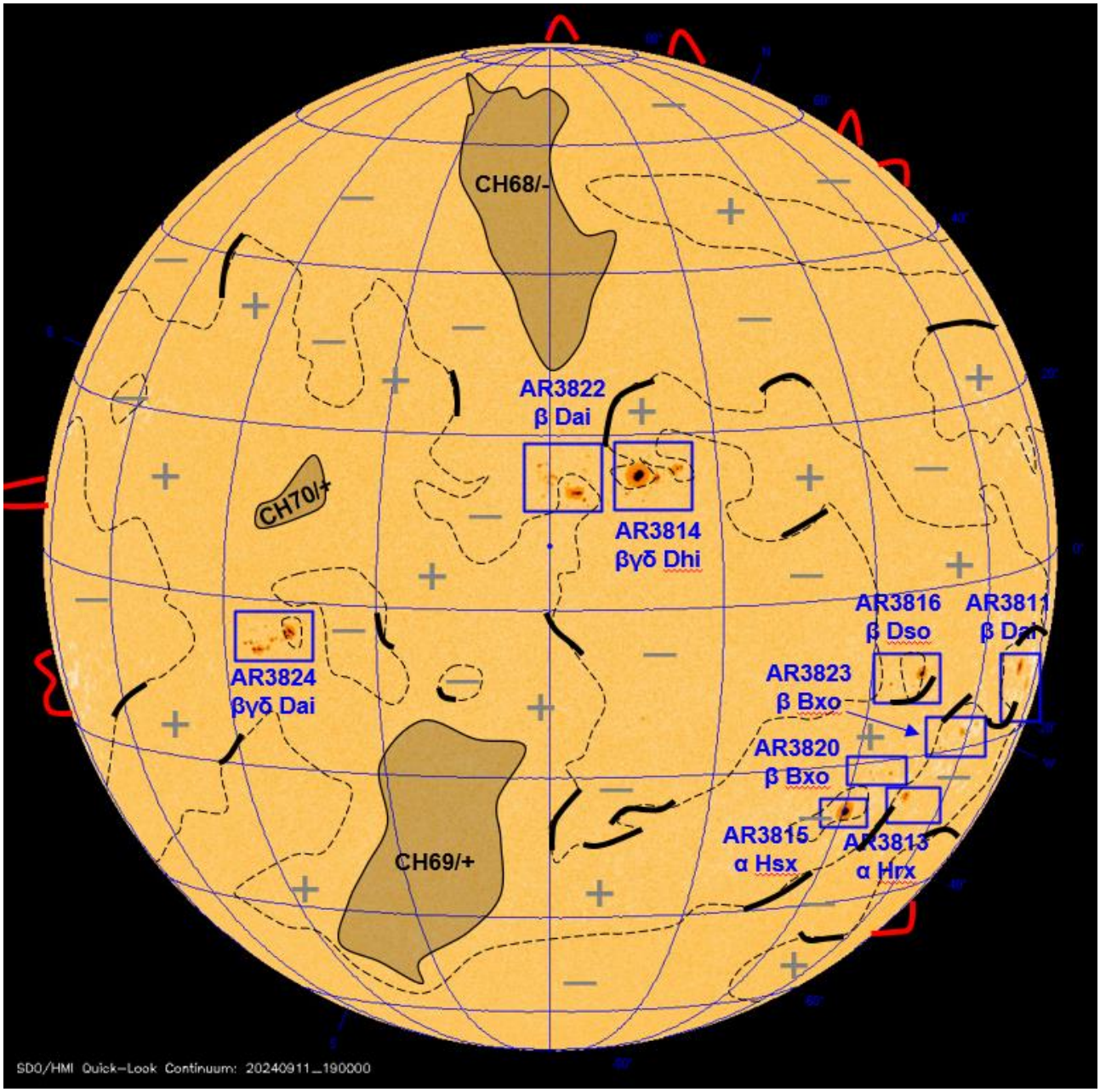
Figure 1. Solar Analysis Valid 11/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Only one Earth-directed CME features in the forecast.

A faint but full halo CME was observed during the early UTC hours of the 10 Sep, following the long-period M1.2 from AR3814. It also produced a type II radio emission with an estimated speed of 408 km/s. The analysis estimated its speed to be around 630 km/s, giving an arrival at Earth late on 12 Sep or early on 13 Sep. The effects of the CME may linger into the start of the UTC weekend.

There is a recurrent coronal hole (CH68/-) currently crossing the central meridian however, it has retrogressed by around a day (13 degrees) on this rotation, which would very likely put any minor 450km/s fast wind at the end of Day 3 (14 Sep) or into Day 4 (15 Sep) rather than Day 2 (13 Sep), as is suggested by the SWPM.

On balance, Quiet to Unsettled conditions should persist for much of Day 1 (12 Sep), followed by an increasing risk of G1-G2/Minor-Moderate Storms early on Day 2 (13 Sep) with a slight chance of G3 / Strong Storm interval. The CME impacts probably lingering into Day 3 (14 Sep), with further Unsettled or perhaps Active intervals. A combination of waning CME influences and the arrival of a high speed stream from CH68/- may increase geomagnetic activity back up to G1 storm levels on Day 4 (15 Sep). However, given the CH negative polarity and we are now approaching the Equinox, it remains uncertain as to how much of an impact the fast wind will have on what could be an already disturbed near-Earth environment following any CME influence. Low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	60	20	5
Strong	G3	No	1	20	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/0526 UTC	Faint full halo	AR3814	NE	630 km/s	13/0600 UTC +/- 9hrs	Limited shock expected

Figure 2: MOSWOC Enlil and Ensemble shows potential CME arrival on 13 Sep.

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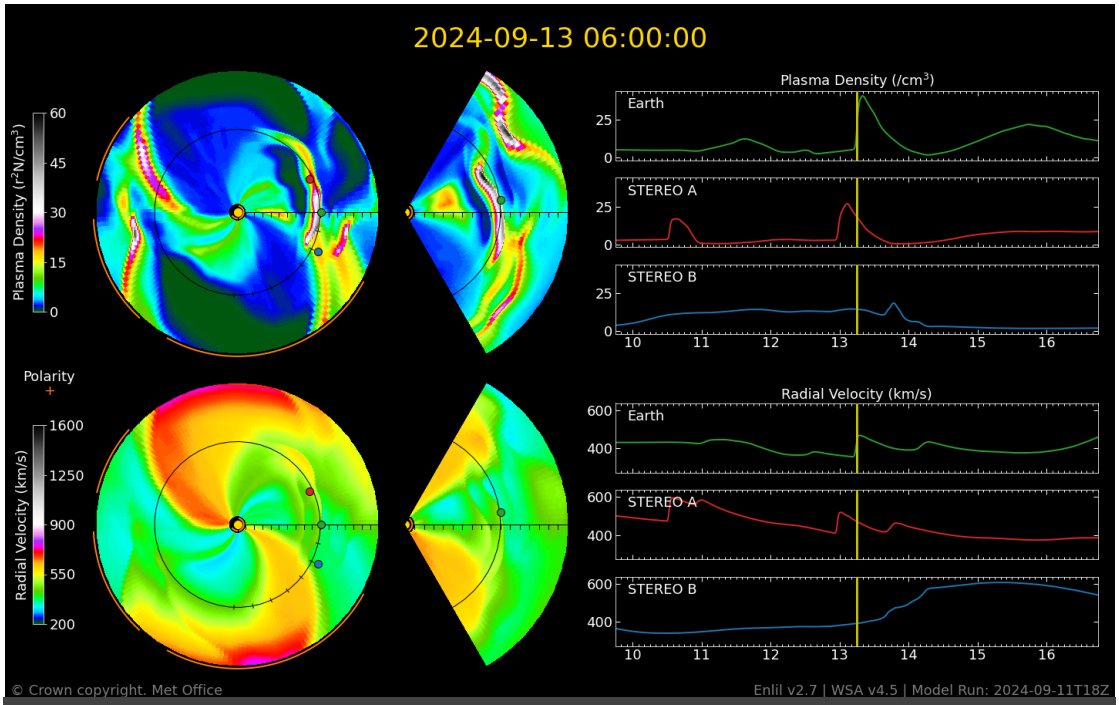

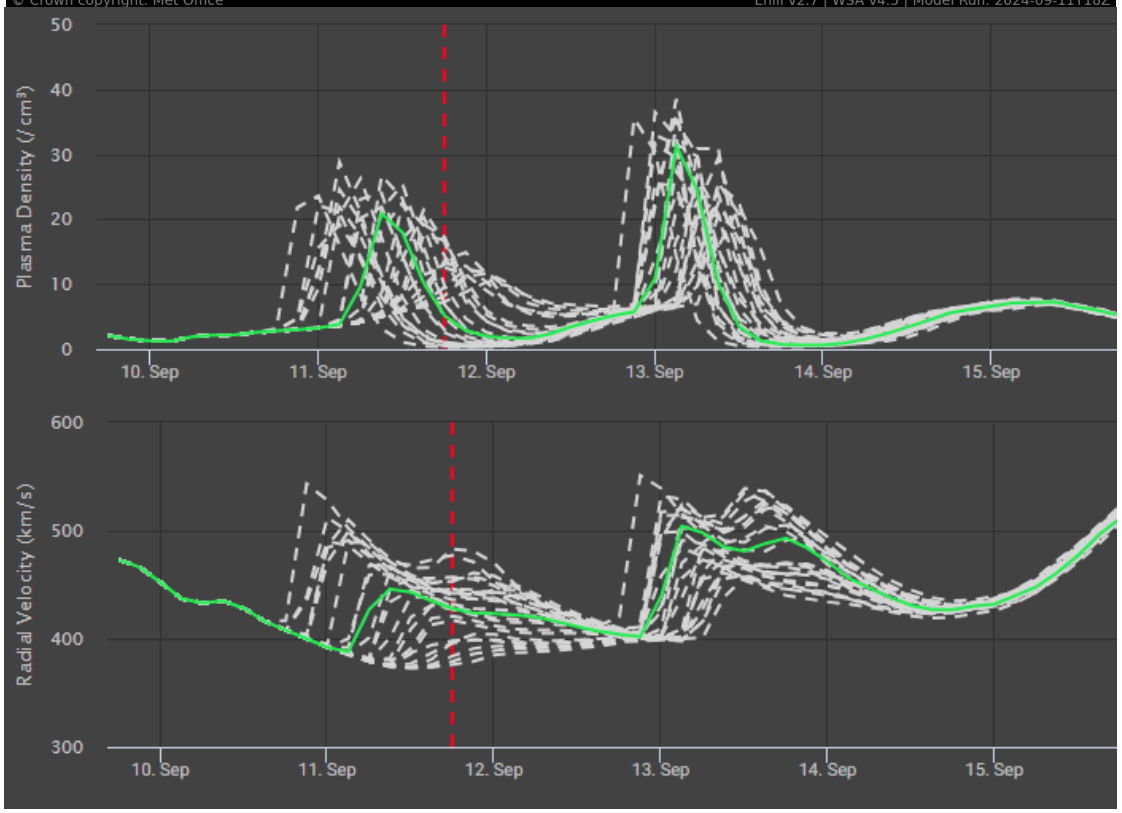

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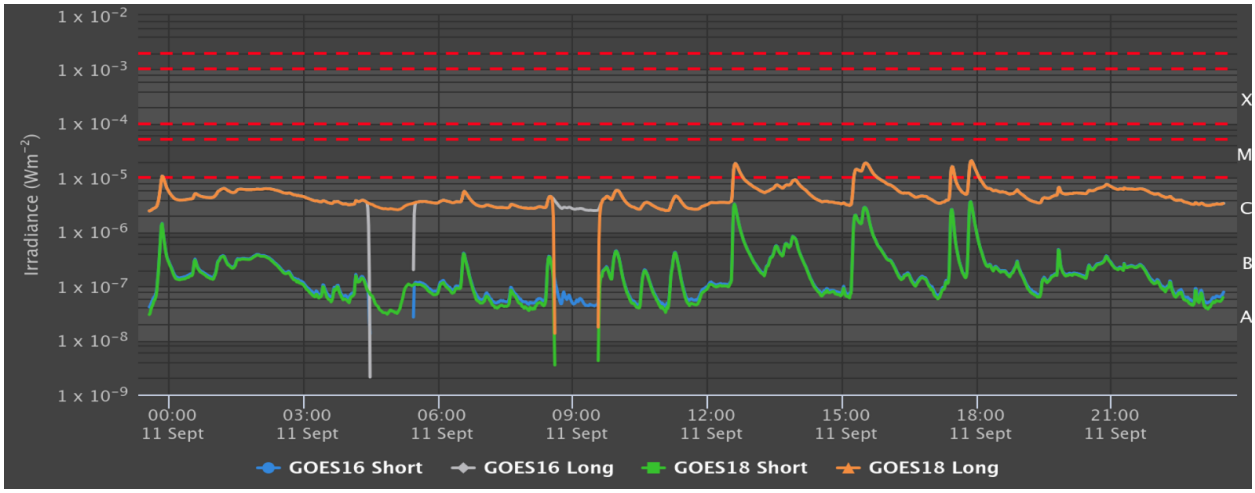
Radio Blackouts - X-Ray Flares:
There are currently nine sunspot regions on the visible disc. Most of the active regions are now on the western hemisphere and appear to be relatively simple and stable. The largest and most complex region is AR3814, just west of the central meridian, in the north. This region recently developed a new delta configuration on its intermediate portion, exacerbating its magnetic instability, as can be seen on satellite imagery. The region immediately east of this, AR3822, appears weaker, with the loss of a couple of spots on its trailing portion. The most significant growth was seen in the newly numbered AR3824 in the southeast quadrant. This has shown rapid development in the recent hours, and it appears to have a delta spot forming within its asymmetric leader spot. This region is now classified a Dai/Beta-Gamma-Delta. AR3821 in the northwest has faded to plage.

The imminently arriving eastern solar horizon encompasses several large returning regions including Ex-AR3790, 92, 93 and 3802, i.e. those roughly between Carrington Longitudes 010 and 025. One of the northern hemisphere regions, perhaps Ex-3802 was responsible for a large and energetic CME in recent days, and was perhaps also responsible for noteworthy far-sided CMEs on 03 and 05 September. As well as this northern hemisphere feature, there appears to be a magnetic connection to the southern hemisphere cluster (for example, AIA171 imagery), and this part of the Sun returning to the facing side of the disc is therefore very likely to result in an upturn in daily flare risk.

Given the likely complex arrivals due in the coming days, the overall risk of significant flares is upwards in the period, with M class Likely and a Slight Chance of X-class.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	70	70	70
Very Active	R3 to R5 X Class	No	10	15	15	15

Figure 3: GOES16/18 X-Ray Flare trace.



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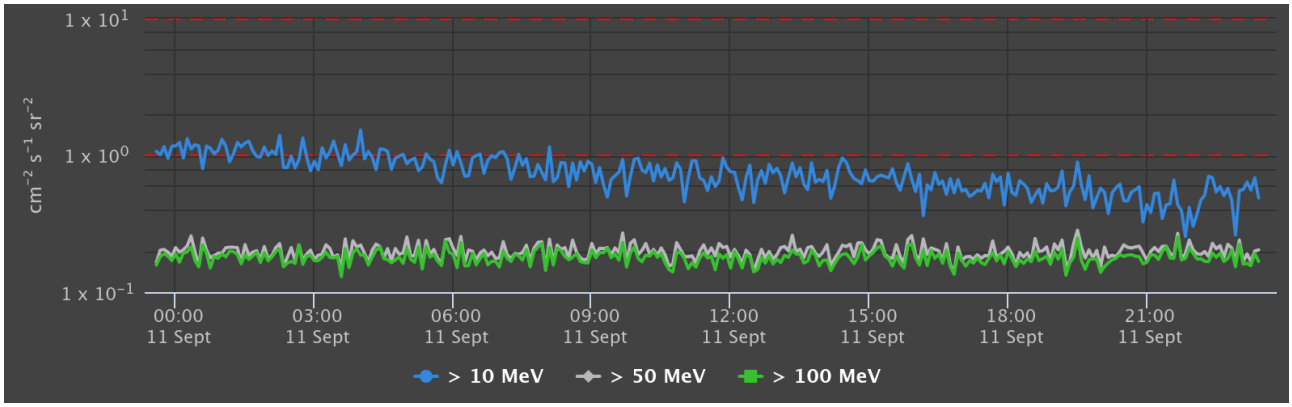
Solar Radiation Storms - (High Energy Protons):
High energy proton flux has continued to show a steady decline to background levels. Further chance of reaching the S1 Minor Radiation Storm threshold in the coming days, if any other significant flaring occurs from the cluster of active regions currently transiting across the southwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux – past 24 hours.



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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux is currently at background, with no fast wind likely to charge the Van Allen belts during this period. The 10 Sept CME (expected on Day 2) may be able to drive a minor increase on Day 3 but nothing significant enough to threaten the corresponding Active 24-hour fluence which remains well below threshold.

All considered, the chances of Active 24-hour fluence are very low throughout.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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